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Quantifying the Volatility of Stock Price Changes in the Indian Market Using the Moving Average Envelope and Bollinger Bands

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Abstract: *A trading system in any stock market is built on long-term, intermediate-term, and short-term indicators. Some 'lagging' indicators, such as the simple and exponential moving averages, can be used to determine the direction of a medium- to long-term trend. Some 'leading' oscillators, on the other hand, can tell a trader whether or not a trend is losing momentum. This paper examines how well moving average envelopes and Bollinger Bands measure stock price volatility, and how useful these technical analysis tools are for short-term horizons. The paper then attempts to evaluate the speed of these indicators in order to explain the sensitivity and response time of data collected from a secondary survey in the Indian capital market. The article concludes that moving average envelopes outperform Bollinger Bands in real trading settings, since technical trading rules are generally designed for short-term investments. Bollinger Bands can detect abrupt price fluctuations, however they are not more effective than moving average envelopes to measure profitability.*

Keywords: Technical analysis; Volatility studies; Moving average envelope; Bollinger Bands, Intraday trading; Sharpe ratio.
JEL Classification: G110, G120, G170

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1. Introduction

The Indian economy has been profoundly affected by the stock market reforms that began in 1991. When the Indian stock market was liberalised, the instruments available to investors had a profound effect on the country's various economic sectors. Because they facilitate the transfer of capital from the government to potential investors, these tools have assumed increasing importance. The stock market was crucial in meeting the demand for liquid capital that emerged during the early stages of economic liberalisation. At the end of the 20th century, the capital market was given more attention as part of the country's policy of reorganisation.

In today's market, in order to create profits, systematic mechanisms are used, which are based on an analysis of a wide range of attributes as well as the historical pattern of price fluctuations (Curcio et al., 1997). The mechanisms of trend, momentum, volume, direction, and volatility all contribute to this perception of the market in their own unique ways. The purpose of this study is to attempt to explain the forecasting of the price movements on the stock market based on the interpretation of the volatility of the data obtained. This is because market volatility is directly proportional to the volume of traded stocks (Kayal & Mondal, 2020). The elements outlined affect stock market price swings.

Technical analysts use the intraday trade filter to forecast stock prices (Curcio et al., 1997). Technical analysis might give systemic profits based on market trends or prior pricing, but as economists suggest, arbitrage can soon destroy these chances. Traders that believe in fundamental analysis will always choose a profitable position based on past market moves. However, fundamental analysis-based traders will eventually drive out other traders. Demir et al. (2020) provide evidence that technological indicators can be helpful in predicting the day ahead electricity market.

Trading strategies, such as Bollinger Bands (BB) and moving average envelope (MAE), are two of the most common and widely used in the industry. BB are a type of channel indicator that were developed by John Bollinger in 1980. These bands reflect the price movements of a stock within a specific range based on the simple moving average (SMA) or exponential moving average (EMA) against a specific standard deviation (SD) below and above the moving average (MA) line. When the actual price crosses either the upper or lower line, a corresponding adjustment is made to the

buy-hold-sell indicator (Leeds, 2012). Calculating the range of volatility for any stock price or index is the basic objective of BB. The BB line should be used as a basis for decision-making for investors based on the junction or cut that occurs when the stock price moves from down to up and *vice versa*. The upper, lower, and intermediate MA lines make up this band. The upper, lower, and middle distance determine volatility. Default values are 2% standard deviations and a 20-period SMA (Bollinger, 2001). MAE, a percentage-based trend-setting indicator, is calculated by mixing the EMA/SMA with a stock's standard deviation. 20 MA periods and 5% SD are usually considered.

In this study, the daily data of 50 NIFTY stocks will be used to calculate volatility using BB and MAE to see how well these technical analysis tools predict day trading risk, and to test how these trading strategies for price, swing prediction in day trading and other short-term investing. The paper will also highlight the sensitivity and credibility of BB and MAE estimates for Indian investors. On the basis of study objectives, three research questions are formed. How do the volatility indicators, BB and MAE, contribute to the process of identifying the level of risk involved in short-term trading in the stock market? What kind of flexibility do these technical analytical instruments have in the short term? And in the context of the Indian market, which technical analysis is more reliable to earn profit in different time frame in short term investment?

2. Literature Review

Taylor and Allen (1992) argue that technical analysis approaches can help traders predict stock price fluctuations. The bootstrap method (Brock et al., 1992) lets us determine acute profitability by collecting data every day (Levich & Thomas, 1993). Shiller (1990) claims that a firm's qualitative explanation for pricing adjustments is more accurate than quantitative explanations of standard models. In contrast to the findings of Silagadze (2008), traders do use the MA indicator when gauging the support and resistance of the various technical analysis lines. They talk about a level of support where most traders believe the price will eventually rise. Using a fixed percentage of information from prior years, Dobson (1994) references Chaikin's Bomar Band.

The literature examines trend, momentum, and direction investigations, as well as volatility measurement. Pheng et al. (2022) investigate stock prediction and financial market risk by crossing trend indicators like Keltner Channel and Hull Moving Average (HMA), or volatility indicators like VIX levels and SKEW index. Li et al. (2020) build a stock forecasting system using long short term memory (LSTM) and incorporate prices and news sentiments. De Souza et al. (2018) use trend-setting exponential MA to simulate trades in BRICS (Brazil, Russia, India and China) capital markets. For stock price trend, Kolková (2017) uses the Fibonacci sequence to EUR/USD forex pair transactions on MT4 for a limited duration using binary options. Gaucan (2011) examines Fibonacci retracements in downtrends and uptrends to predict their efficacy in the foreign exchange market. Conversely, Kumar (2014) describes the trend by considering support and resistance of stock price movements. Morosan (2011) empirically examines the relative strength index (RSI) momentum oscillator set of data and reconfigured the indicator to include trading volume. Then, Sahin and Ozbayoglu (2014) created the trend normalised RSI to calculate directional trends. The efficiency of the RSI was further tested by Halilbegović et al., (2018), who apply a paired sample t-test to compute signal strength.

3. Methodology and Calculation

3.1 Moving average envelope (MAE)

This paper explains how to calculate MAE and BB from the simple MA of the closing prices of NIFTY-listed equity shares. The following equations suggested by Leung and Chong (2003) are used to calculate MAE:

$$SMA_N^{(t)} = \frac{\sum_{i=t-N+1}^{t} P(i)}{N} \tag{1}$$

The moving average envelopes of N-day at time t is defined as:

$$MAE_N^{\%K}(t) = SMA_N(t) \times (1 \pm \%K) \tag{2}$$

Where,

N	Number of days of simple moving average
t	Mean or average of past N days closing share prices
%K	Constant SD percentage

The value of %K determines the extent to which the MAE can vary. The standard deviation of N days' worth of data from the SMA line is used to calculate this percentage. Below is a definition of the trading rules for MAE (Leung & Chong, 2003):

Buy

$$P_N(t-1) < MAE_N^{Low}(t-1)$$
$$P_N(t) > MAE_N^{Low}(t)$$

Sell

$$P_N(t-1) > MAE_N^{Up}(t-1)$$
$$P_N(t) < MAE_N^{Up}(t)$$

3.2 Bollinger Bands (BB)

The Bollinger Band of N-day (Leung & Chong, 2003) at time t is defined as:

$$BB_N^K(t) = SMA_N(t) \pm K \times \sqrt{\frac{\sum_{i=t-N+1}^{t}[P(i) - SMA_N(i)]^2}{N}} \quad (3)$$

Where,

K	Standard deviation on the closing price of the share of Nth day
N	Number of days of simple moving average

$$\%B = \frac{Current\ Close - Lower\ Band}{Upper\ Band - Lowee\ Band} \quad (4)$$

Where,

%B Indicator that reflects the position of the share at a specific date inside of the BB

The value of %B can be negative or more than 1 when the actual share price is outside the bands. At 1, the price of the share is at the upper band, and at 0 it is at the lower band.

The SD, calculated from the closing price and market volume, provides a measure of the BB's breadth (Dobson, 1994). Wideband denotes a low-volatility situation prone to multicollinearity, whereas narrowband suggests a highly volatile share price in the near future. The trading rules for BB are:

Buy
$$P_N(t-1) < BB_N^{Low}(t-1)$$
$$P_N(t) > BB_N^{Low}(t)$$

Sell
$$P_N(t-1) > BB_N^{Up}(t-1)$$
$$P_N(t) < BB_N^{Up}(t)$$

When the security market closes over/under the top/down envelope or band, it is overbought/oversold. Price movement above or below the bands determines buy, hold, or sell (Lento et al., 2007). Thus, when a stock is overbought or oversold, traders should wait until it reaches the band or envelope.

3.3 Samples

The study can be divided into two sections. First, the daily data of 50 NIFTY stocks (December 2020) will be used to calculate volatility using BB and MAE. The beta value of the NIFTY 50 index in June 2022 is used to select five stocks and the index in the second section. Stocks are selected based on data availability from November 2010 to November 2020. The total number of samples for each stock is 2463 (considering 250 working days a year on average). This study shows categorical dependent variables. We begin with the non-parametric chi square test for homogeneity to compare frequencies across categories. The goal is to determine if multinomial observed counts deviate too far from expected numbers.

Let y_{ijk} denote the observed prediction counts corresponding to the i^{th} stock, for the j^{th} prediction time line (j can take values: low, medium and high) by the k^{th} company (k can either be BB or MAE). Also let p_{ijk} denotes the proportion corresponding to the i^{th} stock, for the j^{th} prediction time line. Let n_k be the total number of prediction counts by the k^{th} company. The test statistic that we have used is:

$$\sum_k \sum_i \frac{(y_{ijk} - n_{k*}\, p_{ijk})^2}{(n_{k*}\, p_{ijk})}$$

which follows chi square distribution.

For each of the time lines of prediction, we used the above test separately and attempted to find out whether the two distributions are homogeneous. The two-sample Kolmogorov Smirnov (KS) test is used to determine whether the pairwise frequency distributions are similar, because the chi square distribution does not allow us to consider cell frequencies less than 5. This non-parametric test compares two probability distributions. The following statistic is used to conduct the test:

$$\text{Sup}_x \mid F_1(x) - F_2(x) \mid$$

where F_1 and F_2 are the two probability distributions that are being compared. A box and whisker plot is also drawn to compare between the overall distributions of the frequencies.

4. Analysis and Findings

The below tables (Tables 1, 2 and 3) portray the accuracy rate of prediction of BB and MAE based on the different SMA and SD. It is observed from the table that both the volatility measurement indicators $BB_{20}^{2\%}$ and $MAE_{20}^{2\%}$ are working properly in these specific periods of 10 years. But MAE works better when the numbers of days of SMA are shorter, or the N value is low. When the value of N is higher, BB works better. In this study, 10 years of daily NIFTY data of 50 different stocks are taken into consideration, which shows that the velocity of $MAE_{250}^{2\%}$ and $MAE_{250}^{5\%}$ are very low in case of high SMA. $MAE_{20}^{2\%}$ changes its signal very fast, so any long/short position is converted into short/long. On the other hand, the signal prescribed by the $BB_{20}^{2\%}$ remains the same for a period range of 20 to 50 days of SMA. As the bandwidth of the band is considered in the case of $BB_{20}^{2\%}$, the strength of the signal can be calculated, and based on that, the longevity of $BB_{20}^{2\%}$ can easily be judged.

Table 1: Analysis of $BB_{20}^{2\%}$, $BB_{100}^{2\%}$ and $MAE_{20}^{2\%}$, $MAE_{100}^{2\%}$ of NIFTY 50 (30.11.10 – 30.11.20)

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	20 SMA / 2% SD				20 SMA / 2% SD				100 SMA / 2% SD				100 SMA / 2% SD			
	>100 days	50-100 days	20 -50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50 -100 days	20-50 days	<20 days
ONGC.NS	0	3	43	92	0	1	18	83	6	15	28	46	5	15	24	43
IOC.NS	0	4	52	86	0	0	24	82	7	17	33	39	5	9	26	53
RELIANCE.NS	0	2	49	90	0	0	28	74	9	18	28	34	2	9	30	51
HDFCLIFE.NS	0	0	15	27	0	0	7	27	1	5	8	13	2	4	7	10
TTM.NS	0	1	55	91	0	0	36	76	7	19	29	39	6	13	26	42
HINDALCO.NS	0	2	45	99	0	0	22	85	4	18	31	47	4	15	29	41
BPCL.NS	0	1	46	99	0	0	23	79	5	15	34	44	4	11	32	48
TATASTEEL.NS	0	0	50	98	0	1	33	78	3	19	28	44	6	16	30	36
LT.NS	0	0	52	97	0	0	28	93	5	18	28	35	4	12	33	52
INDUSINDBK.NS	0	2	52	89	0	0	22	93	6	20	29	41	7	10	28	48
UPL.NS	0	2	53	91	0	1	22	82	4	20	33	44	6	11	29	46
SBIN.NS	0	3	49	87	0	0	28	74	7	18	30	36	3	15	31	48
ULTRACEMCO.NS	0	2	45	89	0	1	27	90	4	18	30	41	3	10	32	51
TCS.NS	0	1	43	92	0	0	20	89	7	17	34	43	3	10	28	61
ITC.NS	0	4	47	84	0	0	27	89	8	18	30	34	3	13	30	49
JSWSTEEL.NS	0	0	41	96	0	1	29	66	4	15	27	43	3	16	27	37
NESTLEIND.NS	0	2	50	89	0	0	20	92	5	18	29	42	3	13	29	56

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	20 SMA / 2% SD				20 SMA / 2% SD				100 SMA / 2% SD				100 SMA / 2% SD			
	>100 days	50-100 days	20 -50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50 -100 days	20-50 days	<20 days
HINDUSTAN UNILIVER LTD.	0	3	48	90	0	1	23	86	4	17	35	47	4	15	30	50
POWERGRID.NS	0	2	48	88	0	0	19	81	5	17	29	43	2	8	34	61
ICICIBANK.NS	0	2	51	95	0	0	22	80	1	18	41	48	4	15	33	43
SHREECEM.NS	0	2	50	89	0	1	31	82	6	17	33	40	5	10	28	43
GRASIM.NS	0	2	47	86	0	2	25	87	7	19	27	41	5	14	25	44
HEROMOTOCO.NS	0	1	46	90	0	0	21	90	5	21	31	37	5	12	32	51
BRITANNIA.NS	0	1	48	99	0	1	29	89	6	16	34	43	4	12	23	36
BHARRIART.NS	0	0	48	94	0	0	21	86	0	21	39	45	2	18	28	40
BAJAJFINSERV.NS	0	0	46	95	0	0	27	76	7	18	25	36	7	16	25	38
AXIS BANK	0	5	48	87	0	0	25	79	5	16	29	37	6	13	25	49
CIPLA.NS	0	1	52	89	0	0	24	85	5	16	29	45	4	12	28	51
TECHM.NS	0	2	45	91	0	0	21	79	4	19	31	47	5	16	25	38
WIT.NS	0	3	46	91	0	0	24	82	7	16	29	40	3	16	31	46
ASIANPAINT.NS	0	2	47	87	0	0	26	82	3	13	34	52	4	11	29	47
BAJAJAUTO.NS	0	1	46	90	0	0	22	87	4	19	36	44	1	14	30	49
HCLTECH.NS	0	3	51	85	0	0	21	75	7	18	28	38	4	10	26	50
HDB.NS	0	0	45	94	0	0	25	85	7	20	28	36	5	12	26	47

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	20 SMA / 2% SD				20 SMA / 2% SD				100 SMA / 2% SD				100 SMA / 2% SD			
	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days
MARUTI.NS	0	2	48	90	0	1	25	84	4	18	32	44	5	15	26	39
DIVISLAB.NS	0	2	51	81	0	0	26	86	4	18	32	44	8	14	25	40
HDFCBANK.NS	0	0	44	94	0	0	25	85	7	20	28	36	5	12	26	47
ADANIPORTS.NS	0	4	49	88	0	0	19	76	7	19	30	42	3	8	33	52
COALINDIA.NS	0	4	47	89	0	0	22	85	7	19	25	40	2	15	27	49
DRREDDY.NS	0	2	49	91	0	0	22	93	5	17	35	44	3	12	31	47
EICHERMOT.NS	0	1	45	89	0	0	26	86	5	17	28	47	4	17	26	38
INFY.NS	0	1	48	89	0	0	21	83	7	18	27	35	4	15	28	45
KOTAKBANK.NS	0	1	50	95	0	0	17	91	3	20	35	46	4	9	26	48
MM.NS	0	2	49	94	0	0	18	86	8	19	27	39	6	12	33	47
NTPC.NS	0	1	46	96	0	0	24	82	5	20	31	38	3	10	34	53
SBILIFE.NS	0	1	15	27	0	0	7	23	2	6	6	8	1	4	7	12
SUNPHARMA.NS	0	1	45	93	0	0	15	87	6	15	31	46	5	12	27	49
TATACONSUM.NS	0	1	51	92	0	1	23	86	3	16	34	42	6	14	25	46
TITAN.NS	0	0	50	92	0	0	25	79	4	17	32	43	4	14	29	43
BAJFINANCE.NS	0	0	48	86	0	0	26	84	6	15	29	48	7	13	19	29

Table 2: Analysis of $BB_{20}^{5\%}$, $BB_{100}^{5\%}$ and $MAE_{20}^{5\%}$, $MAE_{100}^{5\%}$ of NIFTY 50 (30.11.10 – 30.11.20)

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	20 SMA / 5% SD				20 SMA / 5% SD				100 SMA / 5% SD				100 SMA / 5% SD			
	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days
ONGC.NS	6	20	34	47	0	2	31	84	1	1	1	1	2	11	37	61
IOC.NS	5	19	39	45	0	1	38	87	2	2	2	2	4	12	34	58
RELIANCE.NS	2	19	43	55	0	1	31	86	1	1	1	1	2	16	30	55
HDFCLIFE.NS	0	3	14	19	0	0	7	26	1	1	1	1	1	3	10	16
TTM.NS	2	17	42	53	0	0	37	87	1	1	1	1	5	12	35	54
HINDALCO.NS	1	21	36	51	0	0	31	94	1	1	1	1	4	13	31	53
BPCL.NS	2	16	43	62	0	0	30	88	2	2	2	2	3	12	36	58
TATASTEEL.NS	7	19	35	48	0	1	31	89	1	1	1	1	5	14	36	48
LT.NS	3	18	40	50	0	0	36	92	1	1	1	1	2	12	35	59
INDUSINDBK.NS	3	12	44	55	0	2	39	87	1	1	1	1	4	12	37	54
UPL.NS	4	17	42	54	0	1	25	86	2	2	2	1	3	12	30	54
SBIN.NS	4	17	39	50	0	1	28	88	1	1	1	0	2	13	41	60
ULTRACEMCO.NS	3	12	40	55	0	0	35	95	1	1	1	0	1	11	45	70
TCS.NS	2	10	45	58	0	2	34	91	1	1	1	0	2	11	38	61
ITC.NS	5	14	39	50	0	5	37	82	1	1	1	0	2	14	37	54
JSWSTEEL.NS	2	16	41	54	0	0	28	80	1	1	1	0	4	11	30	58
NESTLEIND.NS	2	13	42	56	0	5	32	85	1	1	1	0	3	10	40	62

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	20 SMA / 5% SD				20 SMA / 5% SD				100 SMA / 5% SD				100 SMA / 5% SD			
	>100 days	50-100 days	20 -50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50 -100 days	20-50 days	<20 days
HINDUSTAN UNILIVER LTD.	2	11	44	59	0	5	36	86	1	1	1	0	2	13	39	61
POWERGRID.NS	4	19	34	52	0	2	38	81	2	2	2	1	0	10	42	59
ICICIBANK.NS	3	17	44	56	0	2	33	86	1	1	1	0	1	10	38	62
SHREECEM.NS	0	17	41	57	0	0	40	86	1	1	0	0	4	9	36	54
GRASIM.NS	4	13	41	53	0	5	29	92	1	1	0	0	1	13	34	56
HEROMOTOCO.NS	3	19	38	50	0	0	31	91	1	1	0	0	1	9	46	63
BRITANNIA.NS	3	15	42	62	0	1	39	87	2	2	1	1	4	14	35	43
BHARRIART.NS	3	16	42	53	0	1	34	85	1	1	0	0	1	13	41	54
BAJAJFINSERV.NS	1	12	48	64	0	1	34	88	2	2	1	1	4	16	29	48
AXIS BANK	4	15	41	55	0	0	35	94	2	2	1	1	5	14	31	49
CIPLA.NS	3	16	41	54	0	5	34	82	1	1	0	0	2	14	35	53
TECHM.NS	3	16	37	57	0	1	26	95	1	1	0	0	2	16	32	48
WIT.NS	3	12	43	58	0	3	42	82	1	1	0	0	3	13	37	51
ASIANPAINT.NS	1	13	45	56	0	2	37	86	1	1	0	0	1	16	36	53
BAJAJAUTO.NS	3	15	39	56	0	3	30	89	1	1	0	0	2	12	39	62
HCLTECH.NS	0	12	48	62	0	1	32	86	1	1	0	0	3	13	33	58
HDB.NS	3	10	43	63	3	7	35	65	2	2	1	1	5	11	36	55

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	20 SMA / 5% SD				20 SMA / 5% SD				100 SMA / 5% SD				100 SMA / 5% SD			
	>100 days	50-100 days	20 -50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50 -100 days	20-50 days	<20 days
MARUTI.NS	3	12	42	59	0	1	35	88	1	1	0	0	4	14	33	47
DIVISLAB.NS	3	12	45	57	0	4	44	80	2	2	1	1	4	15	31	54
HDFCBANK.NS	3	10	43	63	3	7	35	65	2	2	1	1	5	11	36	55
ADANIPORTS.NS	3	16	41	53	0	0	22	89	1	1	0	0	2	8	34	66
COALINDIA.NS	4	16	37	44	0	3	38	86	1	1	0	0	0	11	33	62
DRREDDY.NS	2	14	46	62	0	4	41	86	1	1	0	0	2	13	39	60
EICHERMOT.NS	3	14	37	56	0	1	28	95	1	1	0	0	3	16	31	48
INFY.NS	4	12	41	58	0	4	38	83	1	1	0	0	4	12	30	53
KOTAKBANK.NS	1	15	44	62	0	3	33	89	2	2	1	1	1	10	40	61
MM.NS	1	13	50	62	0	1	32	91	1	1	0	0	2	13	38	64
NTPC.NS	4	19	37	44	0	2	40	83	1	1	0	0	0	10	40	67
SBILIFE.NS	0	4	13	19	0	1	9	22	2	2	1	1	1	4	7	14
SUNPHARMA.NS	2	12	45	60	0	1	31	96	1	1	0	0	2	10	41	62
TATACONSUM.NS	3	17	39	56	0	1	36	84	1	1	0	0	4	12	37	57
TITAN.NS	1	12	44	67	0	0	27	92	1	1	0	0	4	15	31	52
BAJFINANCE.NS	0	10	43	67	0	0	33	89	1	1	0	0	4	14	30	38

Table 3: Analysis of $BB_{250}^{2\%}$, $BB_{250}^{5\%}$ and $MAE_{250}^{2\%}$, $MAE_{250}^{5\%}$ of NIFTY 50 (30.11.10 – 30.11.20)

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	250 SMA / 2% SD				250 SMA / 2% SD				250 SMA / 5% SD				250 SMA / 5% SD			
	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days
ONGC.NS	9	12	20	25	7	11	18	31	1	1	1	1	6	10	17	34
IOC.NS	7	10	18	21	7	8	16	20	1	1	1	1	7	12	22	29
RELIANCE.NS	9	14	24	25	5	9	21	32	1	1	1	1	5	9	27	40
HDFCLIFE.NS	2	4	4	4	2	3	5	7	1	1	1	1	1	3	5	8
TTM.NS	8	14	23	33	9	10	18	24	1	1	1	1	8	11	21	34
HINDALCO.NS	10	16	20	22	5	10	18	27	1	1	1	1	4	7	23	35
BPCL.NS	7	13	21	26	5	10	17	21	1	1	1	1	4	8	23	35
TATASTEEL.NS	10	12	18	24	8	10	15	16	1	1	1	1	6	12	17	29
LT.NS	9	14	19	23	6	10	21	29	1	1	1	1	5	14	25	38
INDUSINDBK.NS	7	11	21	38	7	9	15	17	1	1	1	1	8	9	17	24
UPL.NS	7	13	22	28	6	7	17	28	1	1	1	0	5	10	16	32
SBIN.NS	10	13	16	18	6	9	22	28	1	1	1	0	6	10	21	35
ULTRACEMCO.NS	8	14	21	25	4	9	23	31	1	1	1	0	5	8	26	39
TCS.NS	9	16	22	33	5	8	19	34	1	1	1	0	3	9	34	47
ITC.NS	9	12	24	31	6	9	18	30	1	1	1	0	6	11	23	40
JSWSTEEL.NS	9	12	16	23	6	8	13	20	1	1	1	0	5	11	19	27
NESTLEIND.NS	8	12	19	27	8	11	21	31	1	1	1	0	5	11	28	38

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	250 SMA / 2% SD				250 SMA / 2% SD				250 SMA / 5% SD				250 SMA / 5% SD			
	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days
HINDUSTAN UNILIVER LTD.	8	11	21	28	5	8	15	28	1	1	1	0	4	10	26	33
POWERGRID.NS	9	15	19	22	5	11	19	40	1	1	1	0	3	8	31	45
ICICIBANK.NS	10	16	22	32	6	10	16	24	1	1	1	0	7	10	25	34
SHREECEM.NS	7	15	21	31	6	9	20	26	1	1	0	0	5	8	22	34
GRASIM.NS	8	13	22	27	7	11	18	27	1	1	0	0	6	11	22	36
HEROMOTOCO.NS	7	12	22	35	7	10	22	33	1	1	0	0	7	13	27	38
BRITANNIA.NS	8	15	21	29	5	9	18	27	1	1	0	0	4	9	21	32
BHARRIART.NS	7	11	19	24	6	10	18	30	1	1	0	0	6	10	25	42
BAJAJFINSERV.NS	6	14	24	27	8	8	10	18	1	1	0	0	7	8	14	21
AXIS BANK	9	11	16	24	6	10	17	34	1	1	0	0	6	11	21	38
CIPLA.NS	7	9	21	28	6	11	20	39	1	1	0	0	5	10	30	48
TECHM.NS	11	13	19	23	5	11	17	24	1	1	0	0	4	10	21	29
WIT.NS	7	14	17	22	6	13	22	35	1	1	0	0	6	13	26	39
ASIANPAINT.NS	6	12	21	29	7	11	18	30	1	1	0	0	4	12	25	31
BAJAJAUTO.NS	8	12	18	28	5	12	25	46	1	1	0	0	4	11	33	54
HCLTECH.NS	7	14	22	30	4	11	18	32	1	1	0	0	3	9	27	34
HDB.NS	8	13	20	31	5	9	15	25	1	1	0	0	7	12	17	24

Stock name	Bollinger band				Moving average envelope				Bollinger band				Moving average envelope			
	250 SMA / 2% SD				250 SMA / 2% SD				250 SMA / 5% SD				250 SMA / 5% SD			
	>100 days	50-100 days	20 -50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50-100 days	20-50 days	<20 days	>100 days	50 -100 days	20-50 days	<20 days
MARUTI.NS	8	15	22	30	4	9	14	19	1	1	0	0	4	9	17	25
DIVISLAB.NS	7	13	20	26	6	8	8	13	1	1	0	0	7	10	14	20
HDFCBANK.NS	8	13	20	31	5	9	15	25	1	1	0	0	7	12	17	24
ADANIPORTS.NS	9	14	22	23	4	10	19	28	1	1	0	0	4	8	23	42
COALINDIA.NS	6	11	18	26	6	8	18	30	1	1	0	0	6	10	29	41
DRREDDY.NS	4	13	28	34	9	10	13	24	1	1	0	0	8	11	22	24
EICHERMOT.NS	7	11	22	34	5	7	11	19	1	1	0	0	4	7	11	22
INFY.NS	8	15	24	35	7	13	19	31	1	1	0	0	5	11	29	41
KOTAKBANK.NS	7	13	21	32	6	8	14	22	1	1	0	0	8	10	17	23
MM.NS	8	12	18	20	6	9	19	34	1	1	0	0	5	11	28	40
NTPC.NS	7	12	19	27	4	13	27	42	1	1	0	0	2	16	30	50
SBILIFE.NS	2	3	4	5	1	3	4	6	1	1	0	0	1	3	6	10
SUNPHARMA.NS	7	13	23	34	5	8	16	22	1	1	0	0	6	7	20	28
TATACONSUM.NS	6	12	23	32	7	8	13	26	1	1	0	0	7	10	24	34
TITAN.NS	8	13	19	28	5	10	21	26	1	1	0	0	5	11	24	31
BAJFINANCE.NS	6	14	26	44	5	7	7	13	1	1	0	0	5	7	8	15

In this study, two parameters are used, e.g., SMA and SD. To judge the volatility of these indicators, 20 days, 100 days, and 250 days SMA, and 2% and 5% SD are used. The SMA and SD are alternatively used in this study like 20 Days/2%, 100 Days/2%, 250 Days/2%, 20Days/5%, 100 Days/5% and 250 Days/5%.

The MAE rule outperforms the BB rule when N is 10, 20, and 50, but not when N is 100. BB are recommended for long-term investments and MAE for short-term investments. Technical trading rules are frequently designed for short-term investments, hence MAE outperforms BB in real trading settings. BB can detect abrupt price fluctuations, however they are not more profitable than MAE.

The tables show that BB improves with SMA. The MAE's short-term trading advice was more profitable. BBs cannot design lucrative trading rules and underperform buy-and-hold. Mean determines BB width. BB holds at 2%-standard deviation normal distribution explain 95% of pricing variability. Overbought is the state when MAE and BB are at their upper limits, and oversold is the opposite. This is a sign to start buying and selling. BB, however, functions better as N increases.

These are the findings from simulations assuming daily values for short-term trading, based on the collected daily data for each NIFTY 50 stock for ten years. Intraday trading, where 5–15-minute candles have significance for decision-making, has different outcomes. The Tables 1, 2 and 3 represent the frequencies of predictions of volatility by applying BB and MAE. To understand the prediction more clearly, the chi square and KS tests are applied.

To visualise the underlying distribution of the frequency distributions under comparison, we used boxplots:

Figure 1: Distribution of Frequencies for 20 SMA/ 2% SD

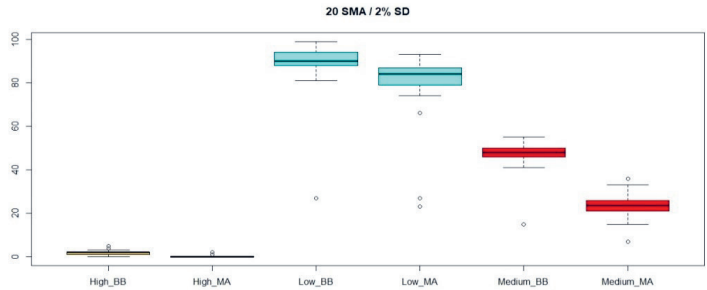


Figure 2: Distribution of Frequencies for 100 SMA/ 2% SD

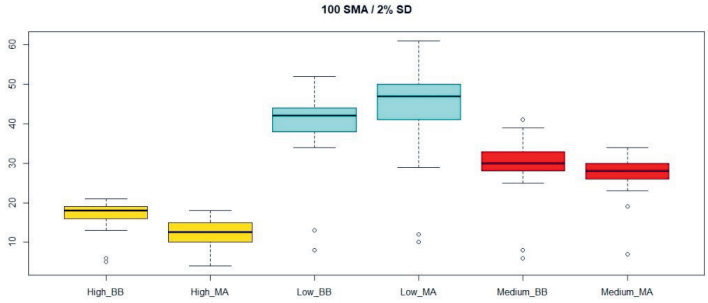


Figure 3: Distribution of Frequencies for 250 SMA/ 2% SD

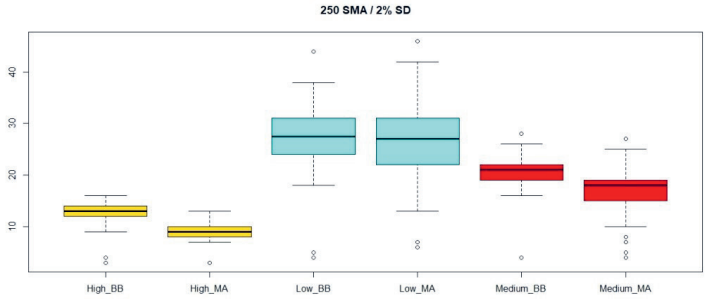


Figure 4: Distribution of Frequencies for 20 SMA/ 5% SD

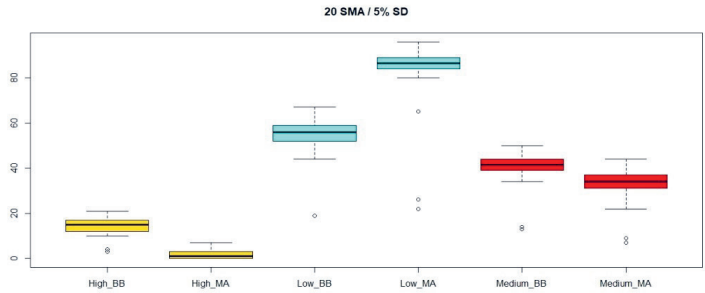


Figure 5: Boxplot on Distribution of Frequencies for 100 SMA/ 5% SD

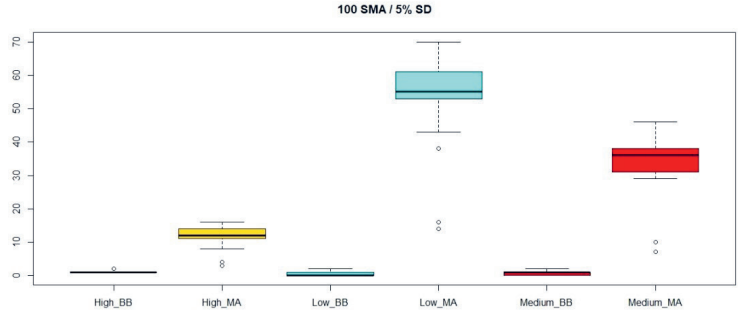
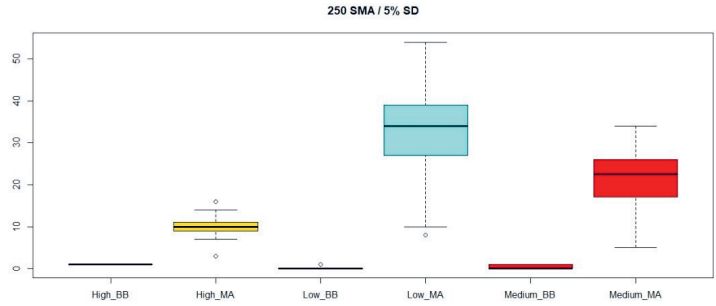


Figure 6: Boxplot on Distribution of Frequencies for 250 SMA/ 5% SD



As shown in Figure 1 and as confirmed by the result of chi square test and KS test, there is no overwhelming evidence of assuming that the distributions are unequal. In short, the results show that the distribution of the counts separately over the categories (high, medium and low) for 20 SMA measured using BB and MA is equal with p values (close to 1 almost everywhere). In this case, the high category can be ignored as it hardly takes non-zero cell counts.

The plots in Figure 2 also get supplemented by the tests. The result shows that there is no difference between the counts corresponding to BB and MA method. Although the p value in favour of the null hypothesis is very high (close to 1) for the high and medium categories, it is slightly less in the context of low category ($p = 0.7796$).

Figure 3 gives us an unique insight. The boxplot shows that there is no significant difference between BB and MA for the categories high, medium and low. The chi square and tests also argue in favour of high and medium

categories (p values close to 1 and 0.8177). But the chi square test for the low category gives a very low p value (p = 0.0020), which shows that although the overall distribution is similar, but the individual cell frequencies differ heavily.

Figure 4 shows that for medium and low categories, the counts given by BB and MA are almost similar (with p values of 0.7997 and close to 1), but differs substantially for the high category (p = 0.0000). However, the latter might be affected slightly because of the presence of some zero values. From Figures 5 and 6 the differences between BB and MA are substantially significant (with p values of 0.0121, 0.0001, 0.0010 and 0.0210, 0.0002, 0.0030 respectively for high, low and medium).

The boxplot also allows us to make a comparative analysis between the categories. It clearly shows that the lower category contains the higher counts, followed by the medium and the higher categories. Table 4 shows the p values corresponding to the tests.

Table 4: p values

	20 SMA / 2% SD	**100 SM / 2% SD**	**250 SMA / 2% SD**	**20 SMA / 5% SD**	**100 SMA / 5% SD**	**250 SMA / 5% SD**
High	0.9999	0.9997	0.9997	0.0000	0.0121	0.0210
Medium	0.9946	0.9997	0.8177	0.7997	0.0010	0.0030
Low	0.9998	0.7796	0.0020	0.9998	0.0001	0.0002

The study also compares the return percentages of BB and MAE. The first part covers 50 NSE stocks. We chose five NIFTY stocks in June 2022 to evaluate if they match the study's conclusions due to the huge sample size, which runs from November 30, 2010, through November 30, 2020. Stocks without price data for the chosen timeframe were excluded. This is why we collected data from companies like India Bulls Real Estate (IBREALEST. NS), Tata Motors Ltd. (TTM.NS), DLF Ltd. (DLF.NS), IDFC Ltd. (IDFC. NS), and Godrej Properties Ltd. (GODREJ.NS) (GODREJPROP.NS) (see Table 5). High-beta stocks traded on the National Stock Exchange of India (NSE) are tracked by this index. The market's sensitivity to stock returns is measured by a factor called beta. Index funds, exchange-traded funds, and structured products can all adopt the NIFTY High Beta 50 Index as a benchmark.

Table 5: Top Constituents, by Weightage of beta, as on June 2022

Company	Weight(%)
Macrotech Developers Ltd.	2.56
Indiabulls Real Estate Ltd.	2.49
Tata Motors Ltd.	2.47
DLF Ltd.	2.45
IDFC Ltd.	2.45
Godrej Properties Ltd.	2.33
Adani Enterprises Ltd.	2.29
Angel One Ltd.	2.23
Steel Authority of India Ltd.	2.23
Delta Corp Ltd.	2.22

Source: NSE

Table 6 illustrates the prediction accuracy of the five sample stocks. The study found that MAE makes 70% accurate predictions when SMA Days or N is 20 to 50, whereas BB performs better in N 100 and 250. Since both bands are narrow, SD 2% is the best prediction (Chakrabarty & Majumdar, 2022). Several conclusions can be drawn on the basis of the comparative analysis, as shown in Table 6. Firstly, for the Indian Stock Market, at SD 2%, if the traders or investors plan for longer investment (100 days to 250 days), they will find the BB prediction more reliable than MAE. If SD is 2%, and the traders or investors have a plan for short term investment (20 days to 50 days), MAE is more reliable than BB. And lastly, in the case of SD 5%, when the band is broader, then investors or traders will find neither of the indicators (BB and MAE) reliable.

Table 6: Percentage of Correct and Incorrect Prediction Returns from BB and MAE

Stock	20 / 2%		20 / 5%		100 / 2%		100 / 5%		250 / 2%		250 / 5%	
	BB	MAE	BB	MAE	BB	MAE	BB	MAE	BB	MAE	BB	MAE
DLF.NS												
Correct	0.17	0.46	0.58	0.53	0.37	0.59	-	0.55	0.58	0.58	-	0.48
Incorrect	0.83	0.54	0.42	0.47	0.63	0.41	-	0.45	0.42	0.42	-	0.52
GODREJPROP.NS												
Correct	0.60	0.56	0.47	0.49	0.27	0.49	-	0.48	0.44	0.45	-	0.56
Incorrect	0.40	0.44	0.53	0.51	0.73	0.51	-	0.52	0.56	0.55	-	0.44

Stock	20 / 2%		20 / 5%		100 / 2%		100 / 5%		250 / 2%		250 / 5%	
	BB	MAE	BB	MAE	BB	MAE	BB	MAE	BB	MAE	BB	MAE
IBREALEST.NS												
Correct	0.56	0.51	-	0.48	0.57	0.53	-	0.53	0.48	0.46	-	0.51
Incorrect	0.44	0.49	-	0.52	0.43	0.47	-	0.47	0.52	0.54	-	0.49
IDFC.NS												
Correct	0.50	0.45	0.53	0.45	0.46	0.48	-	0.55	0.45	0.28	-	0.48
Incorrect	0.50	0.55	0.47	0.55	0.54	0.52	-	0.45	0.55	0.72	-	0.52
TTM.NS												
Correct	0.45	0.53	0.59	0.52	0.48	0.54	-	0.53	0.42	0.42	-	0.49
Incorrect	0.55	0.47	0.41	0.48	0.52	0.46	-	0.47	0.58	0.58	-	0.51
NIFTY 50												
Correct	0.60	0.56	0.59	0.54	0.50	0.55	-	0.48	0.42	0.58	-	0.62
Incorrect	0.40	0.44	0.41	0.46	0.50	0.45	-	0.52	0.58	0.42	-	0.38

Sharpe and Sortino ratios were used to re-evaluate stock volatility. Table 7 calculates the stock return Sharpe ratio, which compares risk-adjusted returns. Standard deviation assumes symmetrical returns. For asymmetrical return distributions with skewness > 0 and kurtosis > 3, the Sharpe ratio is unreliable (Chakrabarty & Majumdar, 2022). From the above table, it shows that the daily Sharpe ratio is negative in all cases, i.e., stocks are highly volatile and can be judged by the volatility-based indicators BB and MAE.

Table 7: Daily and Annual Sharpe Ratio of Sample Stocks and NIFTY

	Daily Sharpe ratio					
	DLF	GDPRP	IBREAL	IDFC	TTM	NIFTY
Mean of excess return	-1.98%	-1.92%	-1.97%	-2.01%	-1.99%	-1.96%
Risk free rate of return	2%	2%	2%	2%	2%	2%
STDEV of excess return	3%	2%	4%	3%	3%	1%
Sharpe ratio (daily)	-0.64	-0.86	-0.53	-0.79	-0.73	-1.76
Annual Sharpe ratio						
Annual return/CAGR	-5.62%	13.35%	-9.12%	-10.45%	-5.87%	8.17%
Risk free rate of return	2%	2%	2%	2%	2%	2%
Annual STDEV/ annualised volatility	49%	35%	59%	41%	43%	18%
Sharpe ratio (annual)	-0.16	0.32	-0.19	-0.31	-0.18	0.35

Negative deviation is also important in terms of loss related with performance, which can be measured by Sortino ratio. Table 8 is a Sortino representation of the returns of the five stocks and index, which shows unfavourable risks. The Sortino ratio improves on the Sharpe ratio, which helps investors evaluate the success of an investment after taking risk into account. The Sortino ratio is unique because it distinguishes between up and down risks (Chakrabarty & Majumdar, 2022). To be more specific, despite the fact that the Sharpe ratio gives equal weight to both positive and negative risks, it nonetheless provides an accurate rate of return when taking the chance of a loss into account.

Table 8: Daily Sortino Ratio of Sample Stocks and NIFTY

	DLF	GDPRP	IBREAL	IDFC	TTM	NIFTY
Sum of (return - risk free return)^2	283%	186%	341%	229%	235%	123%
Risk free rate of return (Rf)	2%	2%	2%	2%	2%	2%
Number of sample	2438	2438	2438	2438	2438	2438
Downside variance	0.12%	0.08%	0.14%	0.09%	0.10%	0.05%
Downside deviation	0.03	0.03	0.04	0.03	0.03	0.02
Mean of excess return	-1.98%	-1.92%	-1.97%	-2.01%	-1.99%	-2.52%
Sortino ratio (daily)	-0.58	-0.70	-0.53	-0.66	-0.64	-1.12

5. Conclusion

The value of %K is what establishes the level of volatility in the case of MAE. As %K increases, volatility will be determined to a greater extent. As a result, the quality of the signals produced by the indicator will deteriorate. Based on the analysis, BB is ineffective for short-term investments. Butler and Kazakov (2010) suggest that particle swarm optimisation (PSO) may yield better results for this dataset. MAE outperforms BB when the number of days or investment period is decreased. The inquiry revealed that both indicators need a standard time to produce an adequate indication. As a direct result of this, engaging in intraday trading with this type of volatility indicator is not possible. Momentum indicators, such as the MACD or the RSI, have the potential to deliver superior results in this circumstance. When it comes to making a buy-hold-sell decision when the investment

term is moderate, BB that have the suitable bandwidth can be of assistance to traders. BB can predict stock price swings, while MAE cannot. Kyriakou et al. (2020) examines how feedback trading tactics affect three simulated real estate portfolios to establish long-term market volatility. Consequently, it is possible to assert that neither volatility-based indicator is capable of producing results that are satisfactory for intraday or short-term trading (Abbracciavento et al., 2022).

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